Root development and configuration in intensively managed radiata pine plantations

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Summary In south-east Australia, where radiata pine (Pinus radiata D. Don) is grown on sandy soils low in nutrients and short of water, early establishment, and rapid growth to canopy closure lead to increased productivity. At this stage demands for nutrients and water are high, and trees respond vigorously to silvicultural inputs.

For several months after transplanting in winter roots are confined within a narrow planting wedge, low temperature restricts new root growth and slows recovery from water stress in plants. From spring, depending upon the configuration and vigour of the roots transplanted, lateral roots extend radially throughout the soil.

Although there were small decreases in concentration of roots radially from the stems of very young trees, such spatial differences disappeared between ages 2 and 3, so that rooting density was independent of distance from the stem. The pattern of vertical distribution of lateral roots was not influenced by age and 80-90% of the lateral roots were within the top 30 cm soil. Roots developed rapidly as the trees grew towards canopy closure, but in general the rooting densities of these pines are among the lowest reported for plants. In rapidly growing trees approaching canopy closure, the secondary thickening of the lateral roots was sufficient to double the weight of roots without altering root length.

Knowledge about root growth and root configuration during the early phase of plantation development will assist management decisions where intensive silviculture is practiced, and hence ensure the most efficient use of nutrients and water.

Introduction

In south-east Australia, in order to sustain and increase the productivity of radiata pine (Pinus radiata D. Don) plantations growing on generally infertile podzolized sandy soils, contrasting silvicultural practices are being advocated: intensive silviculture (cultivation, weed control and heavy fertilization) to achieve canopy closure by age 4 to 5, or retention and management of slash, thereby influencing both water (mulching effect) and the nutrients available to trees. The growth of trees during the early phase of a plantation (period of ‘get away’ or ‘site capture’) when young trees respond vigorously to silvicultural manipulations is recognised as critical. During this period the roots confined initially as a mat in a narrow planting wedge, ramify throughout the soil.

In this paper some aspects of the development of roots in radiata pine plantations from transplanting to canopy closure are examined. The work shows how a detailed understanding of the ecological and physiological aspects of root
development and function can aid management decisions and optimise silvicultural practices.

**Transplanting stresses and the growth of new roots**

The environmental and physiological factors that influence the ability of seedlings to produce new roots when transplanted and practical implications of the root growth potential for survival and early growth of outplanted seedlings have been emphasised\(^1\)\(^2\)\(^6\)\(^13\)\(^19\). Two important factors influencing the new root growth and early establishment of pines are the temperature during the planting season\(^1\)\(^6\)\(^7\), and the root configuration of the planting stock\(^7\).

**Effect of soil temperature on root regeneration**

Fig. 1 shows the effect of soil temperature on the growth of non-mycorrhizal new roots, and on the needle water potential in transplanted radiata pine. During the experiments, pots to which seedlings were transplanted were maintained at constant soil temperatures, but shoots were exposed to non-constant air temperatures ranging from a daily minimum of 6–10°C to a maximum of 14–20°C. While the numbers, weight and lengths of root responded markedly to soil temperature, the shape of the response curves differed between root characters. Number of root apices increased linearly as soil temperature

![Fig. 1. Effect of soil temperature on new root growth and midday needle water potential in 8-month-old radiata pine seedlings, 32 days after transplanting to a sandy forest soil. (Data from 6, 10)